# Vowel backness and palatalization in Irish and Scottish Gaelic

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A study in rule scattering

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## 1 Backness in Irish and Scottish Gaelic short vowels

### 1.1 The basic pattern

**Irish vowels: long vowels**

- Main source: traditional descriptions (Ó Maolalaigh 1997, 88ff.)
- Long vowels: between 5 and 8 phonemes ([iː uː eː oː aː] + [ɛː ɔː ɯː])
- In long vowels, backness is independent of the palatalization of flanking consonants (e. g. Ní Chiosáin & Padgett 2012)

(1) a. [kʲuːnʲ] *ciúin* 'quiet'
b. [bʸiːnʸ] *buíon* 'band, company'

**Irish vowels: short vowels**

- Much variation in the descriptions: anything between 3 and 6 phonemes

| 3 vowels | 4 vowels | | 5 vowels | 6 vowels | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| i | i | | i | u | i | u | i | u | i | u |
| e | e | | e | o | e | o | e | o | e | o̟ |
| a | a | ɑ | a | | a | ɑ | æ | | a | ɔ |
| | | | | | | | a | | | |

- Difficulty in phonemicization because the backness of short vowels depends on the palatalization and velarization of surrounding consonants

## 1.2 Previous work

**Basic generalizations**

- The most detailed discussion is by Ó Maolalaigh (1997)
- Most important distinctions:
  - Palatalized vs. non-palatalized consonants
  - Velar(ized) consonants (labials, dorsals, velarized coronals [nˠ lˠ]) vs [d t r n l s] (weakly velarized; Bennett et al. 2015)

(2) Cois Fhairrge Irish (De Bhaldraithe 1975)

| | | | | |
|---|---|---|---|---|
| a. | [ˈmʲiʎə] | *milleadh* | 'destruction' | (Cʲ_Cʲ) |
| b. | [ˈkur] | *cur* | 'putting' | (C_C) |
| c. | [ˈdinʲə] | *duine* | 'man' | (C_Cʲ where $C_1$ is not velar(ized)) |
| d. | [ˈkudʲ] ∼ [kidʲ] | *cuid* | 'share' | (C_Cʲ where $C_1$ is velar(ized)) |
| e. | [ˈfʲis] | *fios* | 'knowledge' | (Cʲ_C where $C_2$ is not velar(ized)) |
| f. | [ˈtʲuki] | *tiocfaidh* | 'will come' | (Cʲ_C where $C_2$ is velar(ized)) |

**Complementary distribution**

- Ó Maolalaigh (1997): statements of allophony + 'minor rules' (in reality lexical specificity)
- Ó Siadhail & Wigger (1975), Ó Siadhail (1989): SPE-style account
  - Underlying three-vowel system /ɯ ə a/
  - 'Vowel separation rules': e g. V → [+back] / C_ʃ, xʲ
- Ní Chiosáin (1991): nonlow vowels are underlyingly underspecified for [±back], receive [±back] specifications by spreading
- Element Theory accounts in a similar spirit: Cyran (1997) for Munster Irish, Anderson (2014) for Old Irish

**Phonological interpretation**

- All these accounts assume that at least in the nonlow vowels the surface forms contain distinct categories [i e] vs. [u o]
- Another possibility is that the vowels *are* in fact central, and the front-back distinction is due to coarticulation

  **Breatnach (1947, §29)**
  'In words like *mion*, *crios*, *lios*, where the vowel is preceded by a palatal and followed by a non-palatal it is sometimes difficult to decide whether a speaker is using an advanced variety of [u] or a retracted variety of [i]. In some words there is definite alternation[...] [b]ut very often the vowel does not strike one as being definitely [i]-like nor definitely [u]-like.'

- Available sources do not permit to test this possibility

**Scottish Gaelic**

- Scottish Gaelic is a closely related language
- The distribution of short vowels in Scottish Gaelic is not drastically dissimilar to that of Irish (Ó Maolalaigh 1997)
- Even explicitly phonological/phonemic analyses of Gaelic do not describe a potentially vertical system (Oftedal 1956, Ternes 2006, Bosch 2010)
- Exceptions:
  - Ó Maolalaigh (1997) (but again with 'minor rules')
  - McConville (2013) (but not very detailed)
- Why is this?
  - Tradition?
  - Genuine difference in vowel distribution?
  - Genuine difference in the magnitude of coarticulation?

# 2 Acoustic study

## 2.1 Methods

**Recordings**

- Irish and Scottish Gaelic
- Wordlist (mostly monomorphemic items) controlled for factors known to influence fronting and backing
  - All three heights
  - Palatalization C vs. C$^{j}$ vs. $\emptyset$ on both sides
  - Place: labial vs. coronal vs. dorsal (in Irish: [s] as fourth category)
- Frame sentence
  - Irish: *Can X go ciúin* 'Sing X quietly'
  - Scottish Gaelic: *Can X dà uair* 'Say X twice'
- 2 repetitions for Irish, 3 repetitions for Gaelic
- Presented in random order using spelling
- So far 1900 tokens (excluding mistakes, vowels other than short monophthongs)

**Analysis**

- Manual mark-up and auditory coding by both authors
- Automatic formant measurement with Praat using FormantPro (Xu 2007–2015)
- Time normalization: average measurements over five periods of equal duration within each vowel
- Sanity check for this presentation: outlier tokens within each vowel and speaker removed (automatic measurement errors, miscategorization)

- Generalized additive mixed models (Wood 2006) fit in R (R Core Team 2015) using package `mgcv`
- GAM(M)s allow us to easily estimate nonlinear effects: our particular interest is the effect of neighbouring consonant palatalization on F2 over time

**Results**

- Today we focus on two speakers
  - Connemara (west)
  - Donegal (north)
  - Both in their 50's
  - Live in Dublin but use Irish daily (home and workplace)
  - Well-embedded in Irish-language cultural networks
- Some comparison with Scottish Gaelic
- Key questions
  - Is there a distinction between phonological categories, or is it all down to coarticulation?
  - What is the distribution of the phonological categories?
  - What is the extent of the coarticulation?

## 2.2 Results: vowel distribution

**The distribution of vowels**

- Our results broadly confirm the overall complementary distribution of front and back vowels, at least in Irish
- (More later on the phonological interpretation)
- One noteworthy (but preliminary) result:
  - Ó Maolalaigh (1997): in the context $C_{[velar(ized)]\_}\ C^j$, there is free variation between front and back vowels
  - We observe significant coarticulation but the vowel is phonologically front in items like *cuid* 'piece', *muid* 'we', *coigil* 'spare, save', *boilg* 'bellies', at least in the Connemara data
  - The sources' 'variation' ([kud$^j$] $\sim$ [kid$^j$]) is probably an artefact of coarticulation

## 2.3 Results: contrast or coarticulation

**Contrast or coarticulation?**

- Non-negligible overlap in the clouds for front and back vowels
- The effects of surrounding consonant place and coarticulation are (unsurprisingly) significant
- However, they are insufficient to account for the front/back distinction

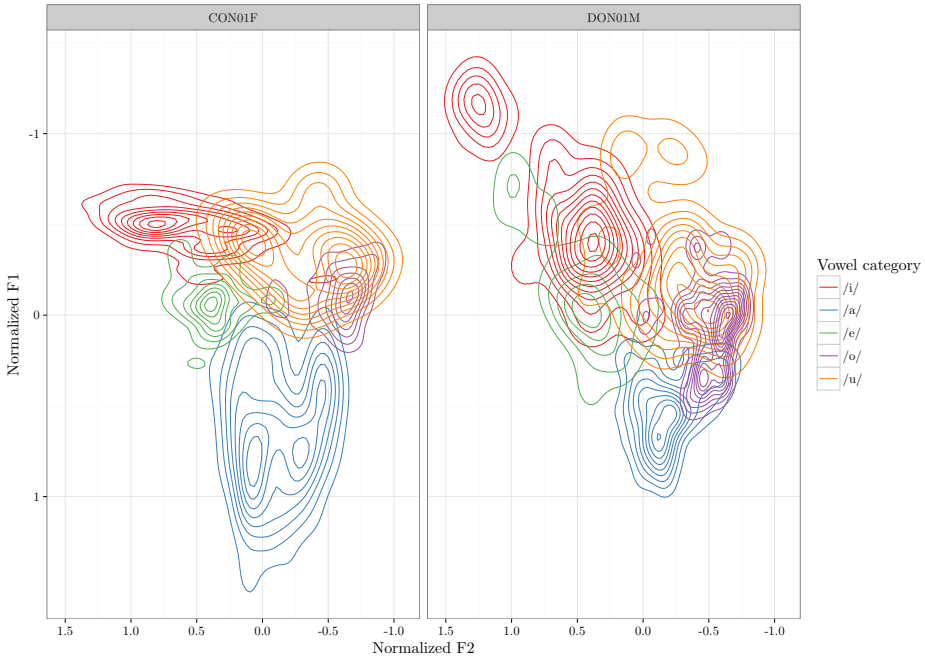


Figure 1: Density of distribution, midpoints, 5-category model

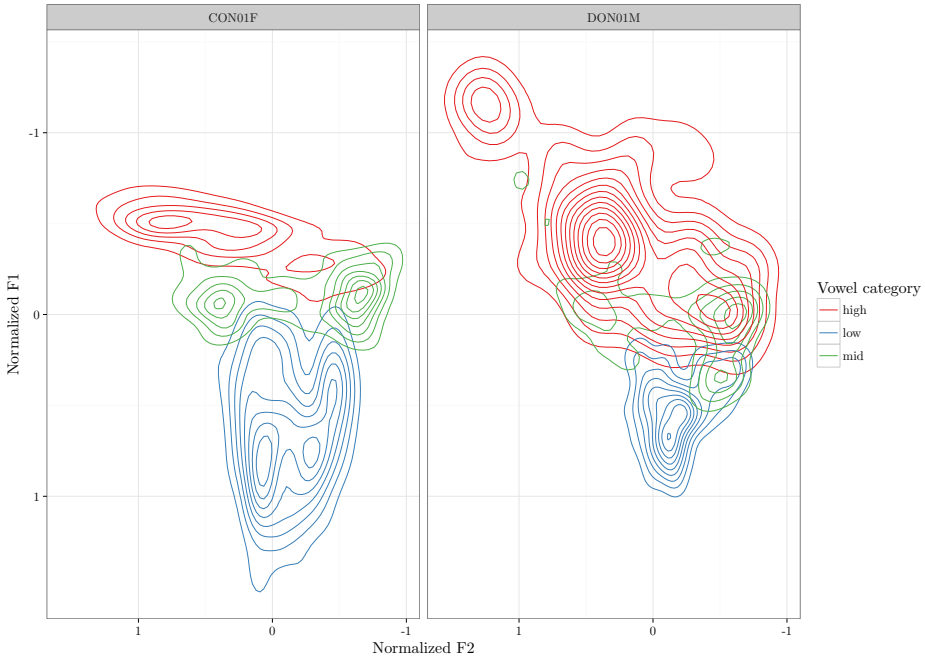


Figure 2: Density of distribution, midpoints, 3-category model

| Model | AIC | BIC |
|---|---|---|
| Five categories | $-1398.07$ | $941.15$ |
| Three categories | $-1397.36$ | $946.08$ |

Table 1: Comparison of five- and three-category models

**The model**

- Dependent variable: F2 normalized by speaker
- Main effects:
  - Vowel
  - Place of preceding and following consonants
  - Palatalization of preceding and following consonants
  - Place $\times$ palatalization interaction for preceding and following consonants
  - Smooth of time by place $\times$ palatalization of preceding and following consonants
- Random effects
  - Random slope by vowel with random intercept by speaker
  - Random intercept by word
  - Random intercepts by preceding and following consonants

**The effect of vowel categories**

- This model assumes five vowel categories: [i u e o a]
- An analogous model that only assumes three categories [high], [mid] and [low] is (marginally) worse at accounting for the variation

- With due caveats, we conclude that the backness distinction is *not* just due to coarticulation
- Previous literature observes the perceptual closeness of some categories (Quiggin 1906, Breatnach 1947, Ó Sé 2000): confirmed

## 2.4 Results: magnitude of coariculation

**Comparing magnitude of coarticulation**

- The effects of place and palatalization on F2 were generally not significant, but the smooths were
- The model allows us to compare the magnitude of coarticulation effects in Irish and Scottish Gaelic
- The magnitude of coarticulation is comparable in the two languages: effect on F2 around $0.2 \pm 0.05$ standard deviations
- (The shape of the curves is more important than the level)

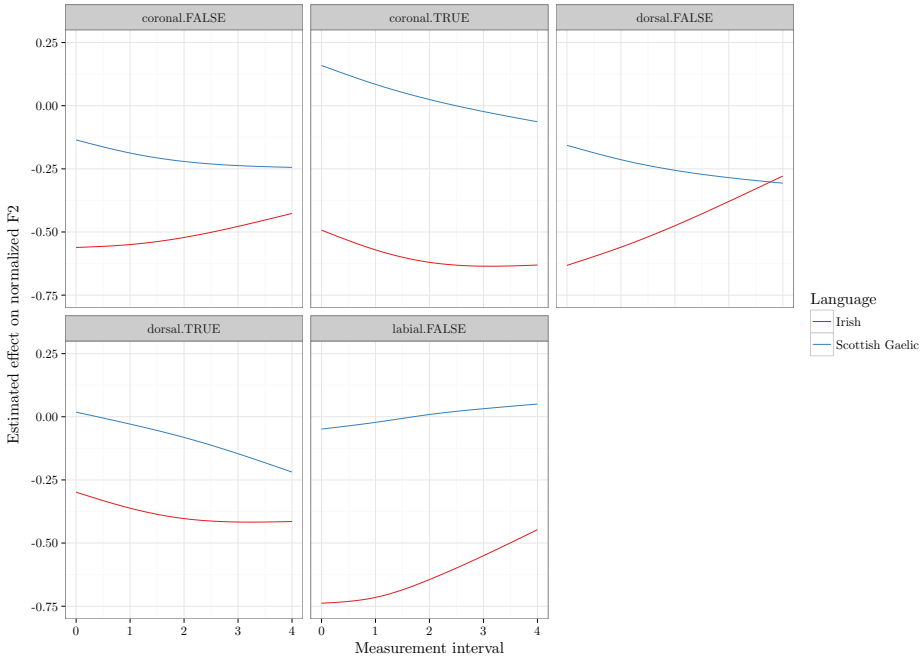


Figure 3: Coarticulation effect of preceding consonant

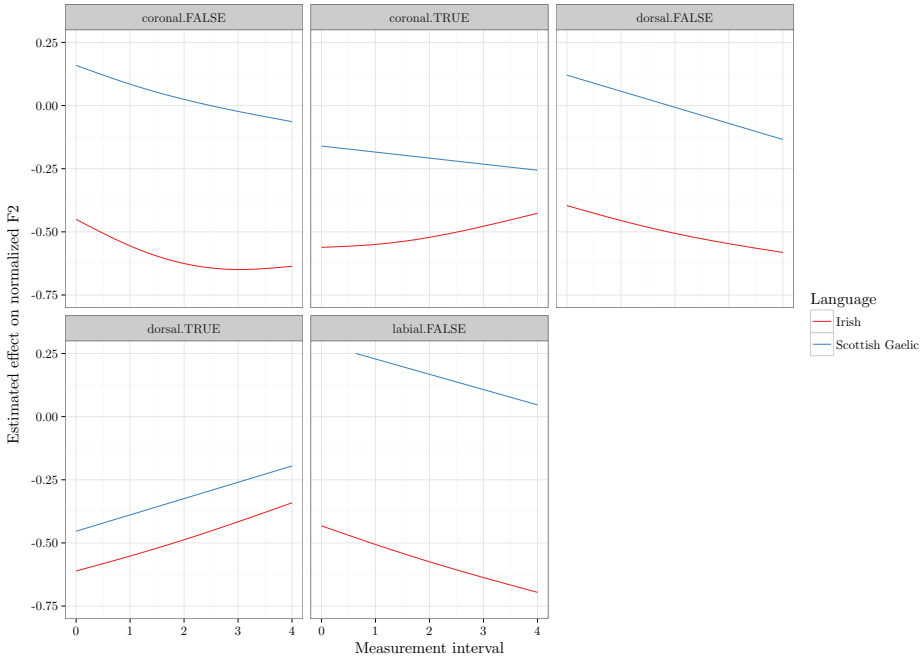


Figure 4: Coarticulation effect of following consonant

**Irish vs. Scottish Gaelic: summary**

- Why are the descriptions so different?
- Not because of the magnitude of coarticulation effects
  - If anything, in Gaelic the coarticulation is somewhat stronger
  - Perhaps because in Gaelic has more segments where palatalization is expressed as a major place distinction rather than secondary articulation
- Current hypothesis: less perfect complementary distribution in the lexicon

# 3 Phonological analysis

## 3.1 The mechanism of complementary distribution

**Complementary distributions and the 5-category model**

- Irish, and to a lesser extent Scottish Gaelic, show largely complementary distributions of front and back non-low vowels
- What is the phonological mechanism by which this arises?
- Approach in much previous literature: two surface categories per height derived from single underlying category
- This study: no strong evidence for anything other than the five [i u e o a] categories
- ☞ Probably more in some varieties
- Why not five categories underlyingly?

**Complementary distributions and the phonology**

- Alternative option: distributions are complementary because processes of fronting and backing conspire to enforce predictable distributions (see also Hall 2013, Iosad & Honeybone 2015)
- Front and back non-low vowels are 'quasi-phonemes' (Janda 2003, Kiparsky 2015): *distinctive*, but *non-contrastive*
- If so, we should find evidence of productive fronting *and* backing rules in the phonology
- This kind of model may be preferred in a generative model (less abstractness), and arguably required in OT due to Richness of the Base

**Fronting**

- Fronting is clearly a productive rule
- Recall the distribution of front vowels:
  - $C^j\_C^j$: [mʲiʎə] *milleadh* 'destruction'
  - #_$C^j$: [ilʲə] *uile* 'all'
  - $C^j$_#: [bʲi] *bith* 'ever'
  - C_$C^j$: [dinʲə] *duine* 'man', [kidʲ] *cuid* 'share'
  - $C^j$_C if $C_2$ is a weakly velarized coronal (Bennett et al. 2015): [fʲis] *fios* 'knowledge'

- This makes sense in frameworks akin to Unified Feature Theory (Clements & Hume 1995) where both coronal major place and palatalization are expressed as [coronal] (cf. Ní Chiosáin 1994)
- (Major-place coronal alone is not sufficient to front)

**Fronting in the morphophonology**

- Fronting is also a productive alternation, expressible as a floating palatalization feature

(3) Coda palatalization

| | | | |
|---|---|---|---|
| a. | [oːr] | *ór* | 'gold' |
| b. | [oːrʲ] | *óir* | 'gold-GEN.SG' |

(4) Coda palatalization feeds vowel fronting

| | | | |
|---|---|---|---|
| a. | [flʲux] | *fliuch* | 'wet' |
| b. | [flʲixʲɪ] | *fliche* | 'wet-GEN.SG' |

- More evidence for floating palatalization feature from the behaviour of clitics before 'onsetless' syllables (Ní Chiosáin 1991)

**Backing?**

- Distribution of back vowels
  - C_#: [du] *dubh* 'black' (even if $C_1$ isn't velarized)
  - #_C: [unəd] *ionad* 'place' (even if $C_1$ isn't velarized)
  - C_C: [kur] *cur* 'putting' (even with non-palatalized coronals)
  - $C^{j}\_C_{[velar(ized)]}$: [tʲuki] *tiocfaidh* 'will come'
- Looks more like the elsewhere case than the result of a rule

**Backing in the morphophonology?**

- Backing in the morphophonology exists but it is the mirror image of fronting

(5)

| | | | |
|---|---|---|---|
| a. | [filʲ] | *fuil* | 'blood' |
| b. | [folə] | *fola* | 'blood-GEN.SG' |

- Could be analysed with a different morphological makeup: /fol+ʲ/

**Backing?**

- So far: little robust evidence for backing
- Two options:
  - We haven't found it yet
  - It is absent
- Potential prediction in the second case: the complementary distribution is less perfect than described
- Exceptions are a work in progress, with particular attention to items for which within-item variation is described

## 3.2 Fronting, backing, and rule scattering

**Rule scattering in Irish**

- We have identified two cognate but distinct sound patterns in Irish (and Scottish Gaelic)
  - Phonetic consonant-to-vowel coarticulation: phonetic realization of palatalization
  - Phonological rules regulating the relationship between phonological specification for palatalization and vowel backness (for short vowels)
- Cut-and-dried case of rule scattering? (Bermúdez-Otero 2015)
- In rule scattering, a continuous phonetic phenomenon (here: consonant-to-vowel coarticulation) is phonologized to produce a phonological pattern (here: fronting and possibly backing) but also remains in the grammar itself

**Rule scattering in Irish?**

- This is a reasonable conclusion on the basis of the synchronic pattern
- Historically, fronting and backing — the phonological congeners of F2 changes — played only a partial role in establishing modern complementary distributions (Ó Maolalaigh 1997, chap. 8)
  - Widespread processes: fronting of /u o/ before $C^j$ (Irish), backing of /i/ before $C_{[velar(ized)]}$
  - Rare processes: backing of /e/
  - Other widespread processes: fronting and raising of /o/ to [i] (Irish), raising of /e/ to [i] (ScG), lowering of /e/ to [a] before C (Irish)

**Rule scattering and between-language differences**

- The differences in distribution arise because Irish underwent more changes creating gaps that lead to complementary distribution
- These processes often involved *height* rather than backness
  - Irish lowering of /e/ $\rightarrow$ [a] / _C creates a gap such that only [o] is allowed in _C
  - Irish: [bʲag] *beag* 'small' vs Scottish Gaelic [beg]

  - In Gaelic the lowering is much more restricted so minimal pairs are possible: [dʒɛx] *deach* 'go-PAST.DEP' ≠ [dʒɔx] *deoch* 'drink'; [beg] *beag* 'small' ≠ [bog] *bog* 'soft' (Wentworth 2006)
- Further suggests that distributional rather than systemic differences are behind the difference in descriptions

**Rule scattering summary**

- The situation in Irish looks like the outcome of rule scattering
- Rule scattering itself is only a part of its origin
- Potentially: such patterns are adaptive in their own right rather than mechanically emerging from the life cycle of phonological processes?

**Summary**

- The descriptions of vowel patterning in Irish and Scottish Gaelic are broadly confirmed
  - There are five (or more) surface categories of short vowel
  - There is significant coarticulation between consonants and short vowels, with significant overlap of the front and back categories
- A coarticulation effect is present in both languages, and is of comparable magnitude
- The differences between the behaviour of backness in Irish and Scottish Gaelic lie in the historically contingent distribution of the vowels across the lexicon, not in the basic nature of the vowel system

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